Space Weather Technical Forecast

Issued on Monday, 11 September 2023 at 13:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further M-flares likely (R1-R2 radio blackouts). Chance of G1 Minor storms 12 Sep due to possible coronal hole connection.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Moderate, with two M-class flares observed in the last 24 hours. The strongest of these was an M1.3 flare from AR3429 at 11/0128 UTC in the northeast quadrant. This gave rise to a CME which is unlikely to be Earth-directed, but will be analysed as data becomes available. A further M1.1 flare was observed at 11/0407 UTC from AR3431, an increasingly complex region in the southeast quadrant, close to the eastern limb. There are 11 sunspots in total, with the two largest regions AR3423 and AR3425 in the northwest and northeast quadrants respectively, are complex but appear stable, with no significant recent activity. AR3430 is also developing, but is currently relatively inactive. Remaining regions are relatively inactive and are only evolving slowly.

No Earth-directed CMEs have been observed in available coronagraph imagery, with a bright CME off the northwest assessed as far-sided.

Solar Wind / Geomagnetic Activity: Solar wind speeds at L1 started at background levels, but have steadily rose to around 400km/s from around 10/2200 UTC. Density started at below average levels, but has increased to around average levels, peaking at close to 10ppcc between 11/0200 UTC and 11/0500 UTC before falling back to background levels. Total magnetic field strength started weakly, but reached moderate levels for a brief time between 11/0001 UTC and 11/0700 UTC. These increases could be the result of a CIR ahead of high speed stream from coronal hole 44, but effects will continue to be monitored before an accurate diagnosis can be made. The north-south component was unremarkable, varying weakly between positive and negative polarities. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity was Quiet throughout.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux has been at background. GOES16 high energy (greater than 2MeV) electron flux was at background. The associated 24-hour fluence was well below the Active threshold, with 2.38e6 integrated pfu observed at 11/0000UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to remain mostly Low with isolated Moderate flares due to a number of complex or developing regions on the visible disc.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. The CIR and subsequent high speed stream from coronal hole 44, may have connected with, or are due to connect with the Earth through 11 or 12 Sep, with recent observations inconclusive. Speeds may reach 550km/s from this feature, or possibly from coronal hole 46 in the southern hemisphere through the next two days. Coronal hole 47 could then connect with Earth, most likely on 14 Sep. Overall, the forecast is for Quiet to Unsettled geomagnetic activity, with a risk of Active or G1 Minor Storms on 11 and 12 Sep. This will likely ease to Quiet to Unsettled 13 Sep, with a subsequent enhancement most likely on 14 Sep, bringing a chance of Active intervals.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at background levels, with a very slight chance of an enhancement should any larger flares occur. High energy (greater than 2 MeV) electron flux is expected to be at background on 11 Sep then likely responding to the fast wind arrival, perhaps increasing to Moderate to High on 12 or 13 Sep, although confidence is low. Overall, the fluence is expected to remain below the Active threshold, but with a slight chance of rising above later in the period.

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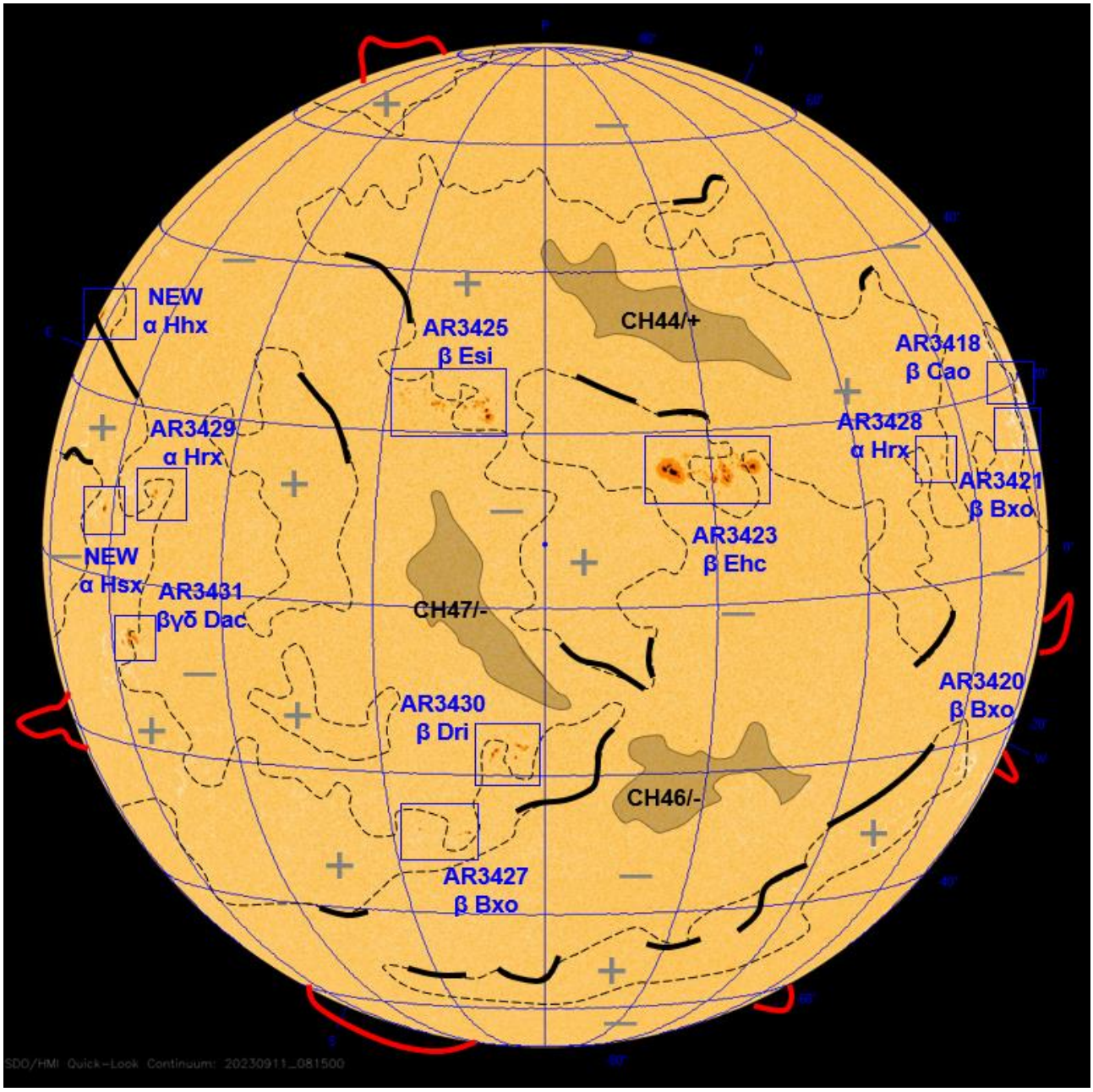
Figure 1. Solar Analysis Valid 11/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

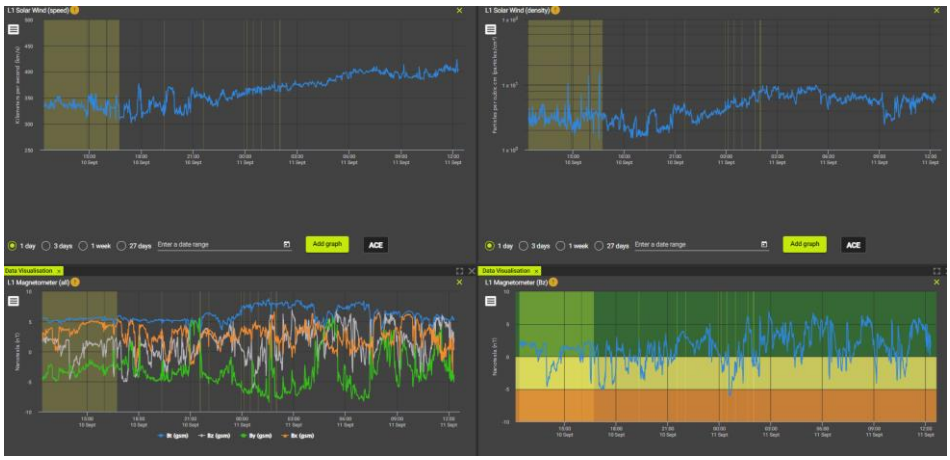
There are no Earth-directed CMEs in the forecast.

Coronal hole 44, in the northwest quadrant is forecast to connect with the Earth either during 11 or 12 Sep. There are signals in L1 data that this is beginning to connect with Earth already, with a recent peak in density and with solar wind speeds increasing and will continue to be monitored. As a positive polarity coronal hole this is more likely to cause a response in the Earth's magnetic field close to the September equinox. Coronal hole 46 may also connect with the Earth around the same time as coronal hole 44, with coronal hole 47 then possibly connecting on 14 Sep. As coronal holes 46 and 47 are both negative coronal holes, any connection is likely to be muted when compared to positive coronal hole 44. Solar wind speeds are around 400km/s due to the possible coronal hole connection, with a further increase possible through the next 36 hours.

Due to the apparent connection to a coronal hole high speed stream, Quiet to Unsettled conditions are expected through 11 and 12 Sep, with a risk of either Active or G1/Minor Storm intervals due to the effects of a possible CIR (co-rotating interaction region) and increase in solar wind speeds. Mainly Quiet then through 13 Sep, with a risk of further Active intervals die to the possible connection to coronal hole 47 on 14 Sep.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	30	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Recent solar wind parameters



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Radio Blackouts - X-Ray Flares:

There are currently 11 sunspot regions on the visible disc, with AR3431 in the southeast quadrant, the most active region. This has a βγδ classification and a complex Dac arrangement. AR3429, despite a simple Hrx arrangement has produced the largest flare and a potential non Earth-directed CME, which may be indicative an increasing complexity. AR3423 continues to be the largest region, but appears stable with no significant activity. AR3425 in the northeast is also large yet stable. AR3430 is also developing, but is inactive. All the remaining regions are evolving slowly and continue to be monitored.

Based on recent activity and the current classification of the sunspots solar activity is expected to remain at Low to Moderate levels, with isolated M-class flares likely through the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	5	5	5	5

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at background levels. There remains a very slight chance of flux levels rising in response to any significant flaring, most likely later in the period as AR3423 and AR3425 continue to move across the western hemisphere.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	10	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) is at background levels, but may start to rise through 11 and 12 Sep, due to inputs into the radiation belts from the coronal hole high speed streams from coronal holes 44 and 46. Diurnal peaks are increasingly likely to reach and exceed the high threshold through 12 and 13 Sep due to the strength of any connection. However this potential rise needs to be balanced against the risk of increased geomagnetic activity and faster solar wind speeds which could disrupt and distort the belts, leading to a reduction in electron flux.

Electron fluence is expected to remain below the Active threshold, due to the balancing probabilities of further radiation inputs against increased geomagnetic activity and distortion of the belts.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	10	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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